ENERGY SURVEY

OF THE

UNITED STATES ARMY
AEROMEDICAL RESEARCH LABORATORY
FORT RUCKER, ALABAMA

EXECUTIVE SUMMARY

CONTRACT NUMBER: DACA01-89-C-0043

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ATLANTA, GEORGIA
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EXECUTIVE SUMMARY

This Prefinal Report is submitted by Jones, Nall & Davis, Inc. (JND) of Atlanta, Georgia and Birmingham, Alabama in partial fulfillment of the requirements to complete the "Energy Survey of US Army Aeromedical Research Laboratory (USAARL) at Fort Rucker, Alabama." This Energy Engineering Analysis Program was commissioned by the Mobile District of the US Army Corps of Engineers under Project Number DACA01-89-C-0043.

A summary of the highlights of the findings and recommendations found in each section of the report is presented below.

A. Utilities

The USAARL consumed 4,820,000 KWH's of electricity from March 1988 through February 1989. This is typical of the electrical usage over the past 5 years. It represents 4.3% of the total KWH usage for the entire Fort Rucker facility. Figure Exec-1 displays the annual electrical energy consumption of the USAARL. The electricity consumption at 40.8 KWH's/S.F. is typical of an office building occupancy in which all systems run 24 hours per day, 365 days per year; or, of a building with high equipment loading and a large lighting load. The latter building concept is the case at the USAARL as confirmed by the DOE-2 model discussed in paragraph D. Figure Exec-2 provides peak demand values for the USAARL as predicted by the DOE-2.1C model. The demand profile shows that electric usage at the USAARL is seasonally dependent as one would expect in the Southeastern US. Since each KW added to or deleted from the summer time billing demand can cost or save up to $97.00 a year, peak shaving of demand is an opportunity to be considered by the USAARL and is discussed in this report.

The average cost per KWH at Ft. Rucker is 4.3¢ and the annual expenditure for electricity for USAARL, based on the rate paid to the Alabama Power Company by Ft. Rucker, is $207,260 per year.

543 MCF of natural gas was consumed in the USAARL between March 1988 and February 1989. This is well below the 5 year average gas consumption for the facility of 972 MCF per year. Total heating BTU's consumed per SF for the year was 4,703 which is very small. This gas usage represents .13% of the

*3.52¢/MMBTU x 1.023 MMBTU/MCF

total gas usage at Fort Rucker. The average cost of natural gas is \$3.61/MCF* (including demand charge) based on Fort Rucker's cost. Thus, the annual cost of natural gas for the USAARL for the referenced year was \$2,004.

Water cost for Ft. Rucker, and hence the USAARL, is 95¢ per 1,000 gallons including sewer charges. No data on consumption was available.

A utility cost summary detailing prices paid for utilities by the USAARL is provided in Appendix 1.

B. Space Survey and Audit

Building survey data for Buildings 6901, 6902, and 6904 is presented in Tables II-2 through II-7 in Section 2. Usage, occupancy schedule, average temperature, average lighting level, lighting wattage, and equipment load is tabulated for each room in the entire USAARL in these tables.

Table Exec-1 provides a summary of the results of this survey of the 277 spaces. It suggests investigation of lighting, cooling and HVAC equipment as sources of energy conserving opportunities.

TABLE EXEC-1

BUILDING ENERGY AUDIT SURVEY

Parameter	Building 6901	Building 6902	Building 6904
Spaces Audited	235	27	15
Average Maximum Personnel	373	32	15
Average Dry Bulb Temperature (^{O}F)	73	69	68.7
Average Lighting Level (Footcandles)	88.5	66.9	52.7

C. Survey and Condition of HVAC Equipment

Surveys of 11 building AHU's, the two AHU's and air cooled chiller serving the simulators, Building 6902 ventilating units and air conditioning units, and those HVAC systems serving Building 6904 are included in Section 3 of the submittal.

Each survey contains a description of how the system was designed to operate as well as a comparison of the actual operation with the design specifications. Control set points are listed and time clock schedules, where applicable, are recorded. The service area for each piece of equipment is recorded and keyed to a master building plan for the USAARL. All data collected during the survey satisfies the requirements of the Scope of Work, Section 3.1.3.

In general, HVAC equipment was found to be in good working order. Equipment and systems were obviously well maintained. In some cases there were deviations from design performance. These deviations suggest the need for a periodic test and balance that reflects the change in occupancy that occurs. All collected data is enumerated in the surveys of individual equipment systems. Where variations can be corrected by routine maintenance, they have been recorded and presented in Section F, Operation and Maintenance Seminar Overview.

D. DOE-2.1C Computer Model and Energy Use Simulation

The energy consumption of the USAARL at Fort Rucker was modeled using the DOE-2.1C building energy simulation program. DOE-2.1C is a large scale hour by hour energy simulation program which can be used to explore the behavior of proposed and existing facilities based on their architectural, electrical and mechanical systems. The program was developed by Lawrence Berkeley Laboratories under the auspices of the Department of Energy.

Energy consumption of the USAARL complex was simulated by the computer model using weather data for Montgomery, Alabama. Comparison of the models predicted energy usage with the actual energy usage as indicated by utility bills is a litmus test for the accuracy of the model. Predicted energy use showed substantial variations when compared to the monthly actual utility readings, but, was in good agreement with the annual total actual energy use for electricity and natural gas. Because the monthly percent differences between predicted and actual values are well within the range of the variation between the actual yearly energy record and the average year energy record shown in Appendix 4, we believe that the DOE-2 energy model adequately reflects the existing complex.

The DOE-2.1C simulation subdivides the annual energy use into subsystems consumption. That division is displayed in the Table Exec-2 and a bar graph and a pie chart presentation of Figure Exec-3 and Figure Exec-4. This table and figures suggests the targets for energy conservation opportunities as lighting, cooling and HVAC auxiliaries since these areas represent 75% of the energy components total.

E. Energy Monitoring and Control System Application

Section V discusses the cost and application program considerations involved in providing an operator's terminal with cathode ray tube visual monitor (CRT) at the USAARL to permit local monitoring and control of existing, as well as new, system equipment status and control points. The Scope of Work for this report called for the expanded EMCS to provide laboratory personnel with the capability to input all data required by applications programs (such as occupancy schedules and temperature setpoints), remotely start/stop equipment, and receive alarms. The Main Control Room (MCR) in Building 1404 would continue to monitor and receive alarms on USAARL equipment, but remote start/stop for USAARL equipment could not be accomplished from the MCR.

The <u>existing</u> Honeywell EMCS architecture within the MCR and the USAARL <u>will not permit</u> all of the capabilities requested in the Scope concomitant with the exclusion of direct control by the MCR. Specifically, if the data base and applications software are to continue to reside in the CPU of the basewide system, then:

1. Data required by applications programs must be, practically speaking, relayed to MCR personnel for program input. (Elsewise, USAARL personnel could access and change all base wide programs which, we understand, in unacceptable), and

2. The MCR cannot be "locked out" from initiating or changing program inputs.

What is feasible with the existing system architecture and the addition of an in-house monitoring and "limited" control terminal is explained in Section V. If the capabilities that can be provided with this system are not satisfactory, then two alternate, and more expensive, system architectures are discussed and priced.

Also examined in the section is the potential for energy savings for EMCS applications suggested in the Scope of Work. Savings calculations are based on the calculational methods and implicit assumptions dictated in NCEL CR 82.030. Jones, Nall & Davis, Inc. believes that some of the application strategies studied and included in the net savings for the EMCS would be ill advised for the lab and so states this position in the discussion of the particular strategy. We also would not endorse the assumptions implied in the calculational procedures prescribed in NCEL CR 82.030. Nevertheless, for informational purposes, we report the potential savings for application programs which could be implemented with the expansion of the EMCS in the USAARL as $13,000 per year with an SIR of 1.02 for the least expensive implementation strategy.

TABLE EXEC-2 - ENERGY USAGE COMPONENTS BREAKDOWN

	ELECTRICITY (MMBTU)	NATURAL GAS (MMBTU)	TOTAL (MMBTU)
HEATING	263.21	1012.91	1276.12
COOLING	4596.90	0.00	4596.90
HVAC AUXILLARIES	4877.93	0.00	4877.93
DHW HEATING	0.00	226.99	226.99
LIGHTING	4432.20	0.00	4432.20
MISC. EQUIPMENT	2958.33	0.00	2958.33
TOTAL	17128.57	1239.90	18368.47

FIG EXEC-3 ENERGY COMPONENTS BREAKDOWN
(BAR CHART)

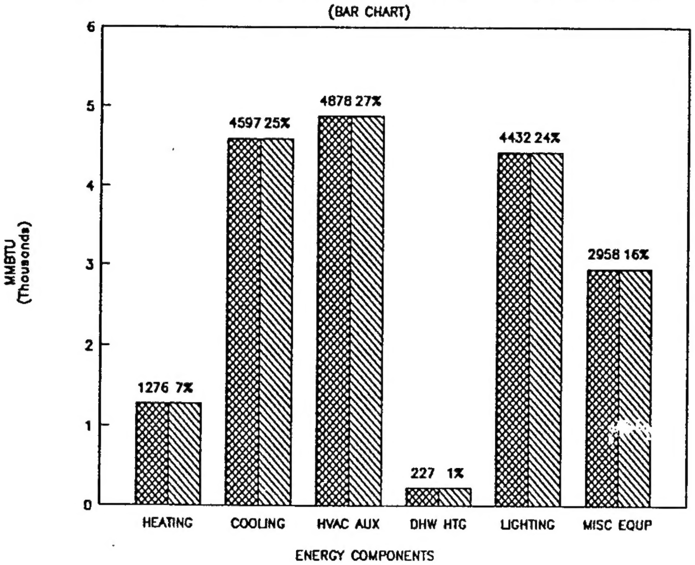
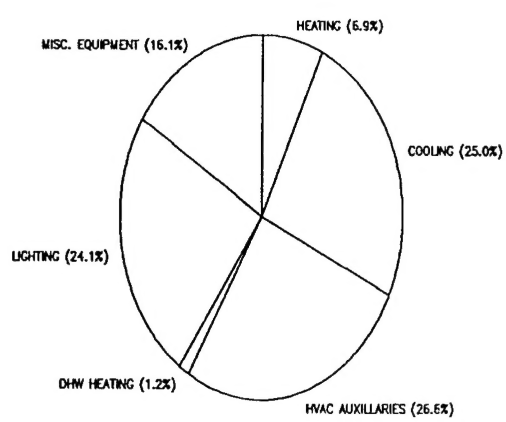


FIG EXEC-4 ENERGY COMPONENTS BREAKDOWN
(PIE CHART)



F. Operation and Maintenance

Table EXEC-4 presents a summary of O & M problems noted during our building survey and recommended corrective action. It is our opinion that the number of O & M problems identified are relatively few for a facility with this many mechanical systems.

Section VII of the Report contains an overview of the operations and maintenance seminar to be presented to USAARL personnel as a partial requirement to satisfy the Scope of Work of the project.

G. Energy Conservation Opportunities

$388,170 worth of energy conservation measures with an annual dollar savings of **$86,462** were identified and found worthy of detailed analysis. A summary of the energy savings, implementation cost, simple payback, and SIR for these Energy Conservation Opportunities (ECO's) is shown in the Table Exec-5A. Each measure is discussed in detail in Section VII. However for the purpose of summarizing, all of the ECOs of Table Exec-5A have been abstracted and placed into the Executive Summary following the tables.

Five of the eight energy conservation opportunities (ECO's) listed in Table 5A were selected by representatives of the USAARL for consideration for concurrent implementation. These measures with their adjusted savings for concurrent implementation are listed in order of decreasing SIR in Table EXEC-5B. Calculation of concurrent and composite savings is explained in Section VII of this Report. The composite savings for the 5 measures is **$79,368** at a composite cost of **$345,410.** Simple payback for all 5 measures implemented concurrently is **4.4 years.**

73 other ECO's which were listed in Annex A to the Scope of Work were addressed at the end of Section VII in the Report. Table EXEC-6 classifies these ECO's as to what system they pertain too and whether they were found to be: already implemented, not applicable, not feasible, or incorporated into the O & M's and ECO's analyzed in this Report.

TABLE EXEC-4 - O & M Improvement Opportunities

Bldg	Equipment /Room	Description	Recommendation
6901	Room J-7	Hot and low air circulation	Route excessive air from Room J-8 to J-7.
6901	Room J-8	Cold and excessive air circulation	Route excessive air from Room J-8 to J-7.
6901	Room K-6	Fume or odor in room	Dark room was designed to exhaust 350 CFM, check any blockage in exhaust duct.
6901	Room K-12	Air leaking out of duct above ceiling	Repair leaking ductwork above ceiling.
6901	Room L-18	Fume or odor in room	Provide exhaust by modifying nearby exhaust systems.
6901	Room BA-18	Hot and low air circulation	Design S.A. was 240 CFM. Requires 500 CFM according to survey data. Route air from adjacent space to BA-18.
6901	Fan EF-8.2	Exhaust fan belt broken	Replace fan belt.
6901	AHU-3	Very dirty final filter	Replace final filter.
6901	AHU-5	Very dirty final filter	Replace final filter.
6901	CLG TWR	About 1/3 of the water distribution nozzles (@ top of twr) was clogged	Clean nozzles to allow water flow freely.
6901	AHU-2	AHU was running continuously ("OFF" clips on AHU time clock was not in place)	Replace "OFF" clips on time clock to allow proper AHU operating schedules.
6901	AHU-8	AHU was running continuously ("OFF" clips on AHU time clock was not in place)	Replace "OFF" clips on time clock to allow proper AHU operating schedules.

H. Programming of ECO's

No projects were identified in the analysis of conservation opportunities that met the Energy Conservation Investment Project (ECIP) criteria of less than 4 years simple payback, SIR greater than 1.0 and a cost greater than $200,000. A summary of ECO's categorized by Army Program is provided in the following Table Exec-7

It is noted that ECO #H and ECO #D are categorized as "Productivity Enhancing Capital Investment Programs". Programming documentation has been provided for those ECOs in a separate volume of this Prefinal Report.

TABLE EXEC-5A

ENERGY CONSERVATION OPPORTUNITY SUMMARY
(STAND ALONE)

ECO #	Description	Annual MMBTU Savings	Annual Dollar Savings	Construction Cost	Simple Payback	Line 6 SIR
A	Provide Energy Efficient Ballasts	684	$12,702	$ 84,491	6.7	1.93
B	Provide High Efficiency Chiller	127	$19,107	$127,356	6.7	1.49
C	Variable Speed Pumping on Chilled Water Pumps	424	$ 4,625	$ 37,265	8.1	1.6
D	De-Energize AHU-6 When Unoccupied	491	$ 2,767	$ 10,289	3.7	2.7
E	Replace Incandescent With Fluorescent	17	$ 723	$ 4,274	5.9	1.00
F	Install Occupancy Sensors in Restrooms	13	$ 104	$ 4,326	41.0	.34
G	Reduce Air Volume on AHU-1	82	$ 2,113	$ 1,169	0.6	17.8
H	KVA Peak Demand Reduction	(2,978)	$44,321	$119,000	2.7	3.85
	Total	(1,140)	$86,462	$388,170	4.5	

TABLE EXEC-5B

ENERGY CONSERVATION OPPORTUNITY SUMMARY
(CONCURRENT SAVINGS)

ECO #	Description	Annual MMBTU Savings	Annual Dollar Savings	Construction Cost	Simple Payback	Line 6 SIR
H	KVA Peak Demand Reduction	(2,978)	$44,321	$119,000	2.7	3.85
D	De-Energize AHU-6 When Unoccupied	569	$ 3,245	$ 10,289	3.2	3.16
A	Provide Energy Efficient Ballasts	653	$12,053	$ 84,491	6.7	1.84
B	Provide High Efficiency Chiller	124	$19,041	$127,356	6.7	1.52
E	Replace Incandescent With Fluorescent	17	$ 708	$ 4,274	5.8	0.95
	Total	(1,615)	$79,368	$345,410	4.4	

TABLE EXEC-6

ANNEX A PROPOSED ECO SUMMARY

ENGINEERING	ALREADY IMPLEMENTED	NOT APPLICABLE	NOT FEASIBLE	JND ECOS AND OPERATION AND MAINTENANCE ITEMS
HVAC	14	6	1	8
Boiler	5	2	-	1
Lighting	-	3	-	2
Building	7	3	-	-
Electrical	2	1	-	2
Plumbing	2	3	1	-
Laboratory	5	-	-	-
Miscellaneous	-	1	1	3
Percent	48%	26%	4%	22%

TABLE EXEC-7

USAARL ECO SUMMARY

ECO Type	ECO Description	Number for USAARL
Energy Conservation Investment Projects (ECIP)	Cost greater than $200,000 Savings to investment ratio SIR > 1.0 Simple payback period (SPP) < 4 years	0
Non Energy Conservation Investment Projects (Non-ECIP)		
. Quick Return on Investment Program (QRIP)	Cost less than $100,000 SIR > 1.0 SPP < 2 years	0
. OSD Productivity Investment Funding (OSD PIF)	Costs greater than $100,000 SIR > 1.0 SPP < 2 years	0
. Productivity Enhancing Capital Investment Program (PECIP)	Cost more than $3,000 SIR > 1.0 SPP < 4 years	ECO #D and #H
. Military Construction Army Program (MCA)	Costs greater than $200,000 SIR > 1.0 SPP < 10 to 25 years	0
. Low Cost/No Cost	Performed with DEH Resources SIR > 1.0	12 O&M's ECO #G ECO #E
Non Feasible Energy Conservation Opportunities	Documented as already implemented; not applicable or not feasible by the AE. No savings to investment ratio or cost or simple payback criteria	52 Items (Annex A) ECO #F

Note: ECO's # A, B and C do not fit any of above ECO descriptions.

ABSTRACTS OF ECO'S

ECO #A
(ABSTRACT)
REPLACE STANDARD BALLASTS IN EXISTING FLUORESCENT LIGHTING FIXTURES WITH ENERGY EFFICIENT BALLASTS

The lighting systems in Buildings 6901, 6902, 6902A and 6904 make extensive use of fluorescent light fixtures. Fluorescent fixtures are recognized as being energy efficient when compared to equivalent incandescent fixtures delivering the same lumen output. In other words, fluorescent lamps deliver more usable light output per watt of electrical energy consumed. Yet, all fluorescent fixtures are not equal in terms of energy consumption and light output. Recent improvements in lamp and ballast design have combined to greatly decrease the energy consumed by the ballast and wasted in the ballast in the form of heat lost to the environment.

THE OPPORTUNITY

Standard ballasts in 1,686 existing fluorescent fixtures consume roughly 240 KW of electricity. By replacing standard ballasts with high efficiency ballasts, the energy used by the lighting system can be reduced by up to 33%, or 80 KW.

THE STRATEGY

Replace 2,505 standard ballasts in fluorescent light fixtures with high efficiency ballasts. Relamp each fixture with new 40 watt lamps to ensure adequate light levels. (32 or 34 watt lamps would reduce light levels below the footcandle criteria requested by the lab personnel.)

RECAP OF SAVINGS

Annual Energy Savings		
Electricity	211,170 KWH OR 720 MBTU	= $ 4,392
	86.7 KW	= $ 8,442
Gas/Oil	(36.5) MBTU	= $ - 132
Total Annual Cost Savings		= $12,702
Total Construction Cost		= $84,491
Simple Payback		= 6.7 years
Line 6 SIR		= 1.93

The estimated useful life of the ECM is 25 years.

ECO #B
(ABSTRACT)
PROVIDE HIGH EFFICIENCY CHILLER TO REPLACE AN EXISTING CHILLER SERVING BUILDINGS 6901 & 6902

The chilled water plant within Building 6901 serves that building and parts of Building 6902. The plant consists of two chillers - neither of which is very efficient by today's standards at providing cooling.

Both chillers are electric centrifugal chillers designed to produce 42^{O} chilled water supply (CHS) although they are often operated at elevated CHS temperatures. WCU-2, at design conditions, can produce 308 tons of cooling at .834 KW/ton efficiency. WCU-1 has a double-bundled condenser designed to facilitate heat reclaim of condenser heat. Its efficiency depends on its leaving condenser water temperature which is controlled to range between 95^{O} and 105^{O}F depending on outdoor temperature. At design conditions and 96^{O}F leaving condenser water temperature, it can produce 330 tons of cooling at .96 KW/ton efficiency. At 105^{O} leaving condenser water, the chiller's efficiency falls off to 1.11 KW/ton and its capacity drops to 226 tons.

Typical high efficiency chillers today can produce cooling at .60 KW/ton and below. Hence, the USAARL is paying a substantial premium in electrical energy to produce cooling with either WCU-1 or WCU-2. WCU-1, the dbl-bundled chiller, is base loaded. This is presumedly to take full advantage of its ability to reclaim heat. Reclaimed heat is used to: 1) preheat domestic hot water, 2) provide heat energy in constant volume reheat coils (there are 68), and 3) provide reheat in variable volume terminal units which have modulated below 50% of their maximum volumetric flow rate.

When a substantial portion of the heat generated by WCU-1 as a by-product of producing cooling can be used to off-set consumption of fossil fuel generated heat, the dbl-bundled chiller is a very efficient machine. The value of reclaimed heat can more than off-set the cost of electricity purchased to operate the chiller. But, when only a small portion of the heat generated by the chiller can be used -- either because its temperature is not high enough for the required process, or the heat load is just not there -- then the dbl-bundled chiller is very inefficient.

An additional efficiency penalty to operate the dbl-bundled chiller that is not evident from the foregoing discussion stems from the inability of the dbl-bundled chiller to unload beyond a minimum tonnage.

A typical high efficiency electric centrifugal chiller with condenser water reset can unload to 15% of full load capacity and thus does not require hot gas bypass.

THE OPPORTUNITY

By operating an energy efficient .6 KW/ton chiller during warm weather months instead of the existing dbl-bundled chiller, about 3/4 of the year's cooling ton-hours can be produced at a KW/ton savings of at least .96 - .60 = .36 KW/ton. The free heat recovery sacrificed by not running the dbl-bundled chiller is equal to only about 30% of the total heat recovered for the year. In addition, operation of a more efficient chiller during May through October will reduce billing demand for the entire year; and, during low load periods occurring in these months, eliminate the need for false loading via hot gas bypass.

Sizing the new replacement chiller for 400 tons will further enhance saving by eliminating the need to run two chillers and two sets of peripheral devices during peak cooling period.

THE STRATEGY

Provide a new 400 ton, .6 KW/ton electric centrifugal chiller to replace the existing WCU-2. Run the new chiller during the warm weather months whenever the actual demand for the month establishes the billing demand for that month at Fort Rucker, (this includes the months of May thru October) Upsize the chilled water and condenser water pumps to serve the new chiller. Interconnect the two cooling tower cells so as to operate in tandem to reject heat from the new 400 ton chiller. Re-use WCU-2's existing electrical service and starter to serve the new chiller (the amp draw will be slightly less for the high efficiency chiller than the existing WCU-2). During months when Fort Rucker's billing demand is established by 75% of a previous month's actual demand, run the dbl-bundled chiller to take advantage of its heat reclaim feature.

RECAP OF SAVINGS			
Annual Energy Savings			
Electricity	308,029KWH or 1051.3 MBTU	=	$ 6,407
	158.8KW	=	$ 15,426
Gas/Oil	(924MMBTU)	=	$ (2,276)
Total Annual Cost Savings		=	$ 19,107
Implementation Cost		=	$127,356
Simple Payback		=	6.7 years
Line 6 SIR		=	1.49

The estimated useful life of this ECM is 25 years.

ECO #C
ABSTRACT
PROVIDE VARIABLE SPEED PUMPING FOR CHILLED WATER SYSTEM BUILDING 6901

The Central Chilled Water Plant within Building 6901 consists of two chillers each with its own 40 HP chilled water pump. The chillers and pumps operate in parallel when both chillers are energized to provide CHW to the cooling coils of 10 AHU's in Building 6901 and 2 AHU's in Building 6902.

All cooling coils have two-way throttling valves which are pneumatically controlled to maintain a constant leaving air temperature from the cooling coil. As load decreases, leaving air temperature controllers direct throttling valves to throttle CHW flow. This causes system head to increase and CHW pumps to "back up" on their curve thereby producing less flow.

As pumps back up on their curve, they save energy -- but not much. That's because as flow decreases, head increases. Since pump horsepower is proportional to flow x head, horsepower is only saved if the fractional increase in head is less than the fractional decrease in flow.

System head need not increase to reduce CHW flow. A more efficient way to decrease CHW flow in response to reduced load is to slow the speed at which a pump's impeller rotates to enable the pump to operate on a new flow/head curve which can match the required system flow and head.

Use of variable speed pumping to reduce the power draw of the two CHWP's at peak cooling loads will have a significant impact on electricity cost of KW billing demand. This assertion is based on the assumption that Fort Rucker's electric actual monthly peak demand in the six warm weather months (when the actual demand de-establishes the billing demand) is established coincident with the requirement to run two chillers and two pumps at the USAARL.

Reduction of 21.0 KW in the USAARL during peak demand periods in May through October will reduce billing demand in these months as well as the six subsequent cool weather months since billing demand in November through April is racheted at 75% of the peak month from the earlier summer months.

THE OPPORTUNITY

By varying the speed of motors driving chilled water pumps to match system flow and head at reduced CHW flow requirements, pumping horsepower can be saved which will lead to KWH as well as KW savings. KW billing demand is saved because at peak load, two chillers and their CHWP's run at approximately 60% of full load capacity to meet the load.

The trick to successful implementation of this ECO is in controlling the pump speed to produce just enough flow and head to satisfy the AHU's cooling coils calling for reduced flow as well as those requiring full flow at the same time.

A scheme which achieves this type of control is to monitor the position of all CHW throttling valves via an EMCS. If all valves are throttling, then the pumps are slowed until at least one valve is 100% open (i.e. calling for the full available flow). If AHU leaving temperature controls call for the CHW throttling valve to open beyond 100% (i.e. calling for more CHW than is presently available), then the pumps are speeded up.

The best way to speed-up or slow-down the pumps is via an electronic variable speed drive.

THE STRATEGY

Provide 40 HP variable speed drives (VSD's) to drive each CHWP motor.

Provide pneumatic to electric transducers in pneumatic lines between receiver controller output and chilled water control valve. Transducers shall convert pneumatic signal to 4-20 ma signal which shall be an input to the Data Gathering Panel of the EMCS system.

Program the EMCS to control both VSD's to speed and slow pump motors in tandem in response to CHW valve position at 12 AHU's.

If the EMCS capability is not provided to control VSD, an alternate strategy to control pump speed can be achieved via a pressure transducer placed in the CHW supply pipe which signals the VSD to slow as pressure builds due to valves throttling.

RECAP OF SAVINGS

Annual Energy Savings			
Electricity	124,287 KWH or 424 MBTU	=	$ 2,585
	21 KW	=	$ 2,040
Gas/Oil	0 MBTU	=	$ 0
Total Annual Cost Savings		=	$ 4,625
Total Construction Cost		=	$ 37,265
Simple Payback		=	8.1 years
Line 6 SIR		=	1.6

The estimated useful life of this ECM is 25 years.

ECO #D
ABSTRACT
DE-ENERGIZE AHU-6 DURING PERIODS WHEN THE MAJORITY OF THE AREAS SERVED ARE UNOCCUPIED

Building 6901 is occupied from 7:30 AM to 4:30 PM, five days per week. The front desk, located in the main lobby, is occupied 24 hours per day, seven days per week. Air handler AHU-6, which serves the lobby, main conference room and library, is operated continuously to ensure the comfort of the front desk occupant. This means that at night and on weekends excess energy is consumed to condition 20,000 square feet of area, of which only 1,600 square feet is occupied. Substantial energy savings can be realized by providing a new air handling unit to serve the lobby only, allowing AHU-6 to be de-energized during periods when most of the area it serves is unoccupied.

THE OPPORTUNITY

By de-energizing AHU-6 at night and on weekends when the majority of the areas it serves are unoccupied, substantial energy cost savings can be realized due to a reduction in electrical energy consumption by the chillers, fuel oil consumption by the boiler, and fan energy consumed by AHU-6.

THE STRATEGY

Provide a new cooling/heating system to serve the lobby and front desk. The system will consist of a roof mounted condensing unit and plenum mounted fan coil. Provide supply and return ductwork and ceiling mounted diffusers to distribute the air in the area of the front desk. Provide a new thermostat and program the existing time clock for off hour and weekend schedules. De-energize AHU-6 at night and on weekends via its time clock.

RECAP OF SAVINGS

Annual Energy Savings

Electricity	117,443 KWH or 401 MBTU	= $ 2,444
	0 KW	= $ 0
Gas/Oil	89.6 MBTU	= $ 323
Dollar Savings/yr.		= $ 2,767
Implementation Cost		= $ 10,289
Simple Payback		= 3.7 years
Line 6 SIR		= 2.7

The estimated useful life of this ECM is 15 years.

ECO #E
ABSTRACT
PROVIDE FLUORESCENT FIXTURES TO REPLACE EXISTING INCANDESCENT FIXTURES IN RESTROOMS

The lighting systems in many of the restrooms in Building 6901 and 6902 consist of a ceiling mounted light fixture containing one 60 watt incandescent lamp. Four of the larger restrooms also contain one or more wall mounted vanity lights which contain one 100 watt incandescent lamp.

Although the restrooms are occupied on an intermittent basis, a spot survey conducted by JND indicates that the majority of the restroom lights are energized continuously for at least 8 hours per day.

Two methods may be employed to reduce the lighting system energy consumption. You may either reduce the hours of operation or reduce the energy consumed during each hour of operation. ECO #F addresses reducing hours of operation by using occupancy sensors to de-energize the lights during unoccupied periods. This ECO investigates reducing the energy consumption of the lights while in operation.

Incandescent lamps use 4.5 times as much energy as fluorescent lamps use to produce a given level of light output. In addition to the obvious energy savings when compared to incandescent lamps, fluorescent lamps last about 10 times as long; saving replacement lamp cost and labor cost to relamp.

THE OPPORTUNITY

The majority of the restrooms in Buildings 6901 and 6902 utilize 60 watt and 100 watt incandescent fixtures for lighting. Energy savings may be realized by reducing the energy consumption per lumen of light output via the use of fluorescent lamps.

THE STRATEGY

Replace existing incandescent fixtures with new fixtures utilizing high efficiency fluorescent lamps.

The 60 watt ceiling mount fixtures can be replaced with a new fixture fitted with a 20 watt fluorescent lamp. A Sharol #205 by Brownlee Lighting is a readily available fixture which meets this specification and will be used in the cost and savings analysis.

The 100 watt wall mounted fixtures can be replaced with a new fixture containing two PL-13 fluorescent lamps. A Hamilton #125 by Brownlee Lighting meets this specification.

RECAP OF SAVINGS		
Annual Energy Savings		
Electricity	4919.2 KWH or 16.8 MBTU	= $ 102
	2.37 KW	= $ 230
Gas/Oil	0 MBTU	= $ 0
Total Annual Energy Cost Savings		= $ 332
Labor Savings		= $ 391
Total Annual Cost Savings		= $ 723
Implementation Cost		= $4,274
Simple Payback		= 5.9 years
Line 6 SIR		= 1.0

The estimated useful life of this ECM is 25 years.

ECO #F
ABSTRACT
INSTALL OCCUPANCY SENSORS TO DE-ENERGIZE RESTROOM LIGHTING FIXTURES DURING UNOCCUPIED HOURS

The lighting systems in many of the restrooms in Building 6901 and 6902 consist of a ceiling mounted light fixture containing one 60 watt incandescent lamp. Four of the larger restrooms also have one or more wall mounted vanity lights which use a 100 watt incandescent lamp.

Although the restrooms are occupied on an intermittent basis, a spot survey conducted by JND indicates that the majority of the restroom lights are energized continuously for at least 8 hours per day. There is even an engraved sign over each light switch reminding the occupant to turn out the light, yet the lights remain on.

Two methods may be employed to reduce unnecessary energy consumption. Either reduce the energy consumed while in operation, or reduce the hours of operation. ECO #E addresses reducing the wattage of the light fixtures by converting from incandescent to fluorescent lamps. This ECO considers the use of occupancy sensors to automatically turn the light fixtures off when the area is unoccupied.

THE OPPORTUNITY

Thirty nine 60 watt and five 100 watt light fixtures consume electric energy to light thirty one restrooms for eight hours each day, regardless of occupancy. Automatically turning the light fixtures off when the restroom is unoccupied can save energy dollars.

THE STRATEGY

Install 41 wall mounted occupancy sensors by Light-O-Matic (Model 01-134) in all eligible restrooms in Building 6901 and 6902. Adjust each sensor to ensure proper operation with no false triggering.

RECAP OF SAVINGS		
Annual Energy Savings		
Electricity	3692 KWH OR 12.6 MBTU	= $ 77
	.28 KW	= $ 27
Gas/Oil	0 MBTU	= $ 0
Total Annual Cost Savings		= $ 104
Total Cost		= $4,326
Simple Payback		= 41 years

The estimated useful life of this ECM is 25 years.

ECO #G
ABSTRACT
REDUCE VOLUME OF AIR DELIVERED BY AHU-1 AND EF-1-4 TO MORE CLOSELY MATCH THE CURRENT USE OF THE SPACES THEY SERVE

Air handling unit #1 (AHU-1) delivers 8,485 CFM of conditioned outside air to 12 rooms in Building 6901, including offices, animal surgical rooms, and a pharmacy. Air volumes ranging from 2.25 CFM/ft^2 to 6.5 CFM/ft^2 are delivered to each space. Although the rooms were designed with extra air delivery because of their specialized designated uses, in reality the rooms are all occupied as offices and don't require the extra air quantity to be occupied safely.

Discussions with lab personnel indicate that the surgical, autopsy, and other specially designed areas could revert to their intended uses at some time in the future, but no definite plans are available at this time.

With the potential future space uses in mind, JND investigated ways of reducing the energy consumption of AHU-1 and its associated systems. A major criteria is that any changes made to the system be easily reversed should the rooms revert back to their designed uses. The system is 100% outside air, constant volume, employing terminal reheat boxes and a plate type heat exchanger to recover enthalpy from the exhaust air stream. The plate type heat exchanger moderates the high energy cost of providing 100% outside air through AHU #1 to the spaces it serves. For example, during extremely cold weather, a 50% effective heat exchanger can warm 25°F incoming outside air to 50°F. Then the AHU's heating coil must only expend energy to warm the 50°F air another 5°F or 10°F. Nevertheless, reduction of outside air quantities can save energy.

Conversion to variable air volume (VAV) operation or addition of a variable speed drive on the fan are solutions but another strategy is more appropriate.

Installation of different sheaves and belts on the AHU and exhaust fans and fan motors could allow a fixed change in the fan speed and the air volume delivered at a minimal cost and allow easy reversion of the AHU to its original design CFM delivery.

THE OPPORTUNITY

AHU-1 delivers two to six times the normal quantities of air to a 2,300 square foot area of Building 6901. Designed as surgical and surgical support areas, most of the rooms are presently used as offices. Reducing the quantity of air delivered to the spaces to an acceptable minimum based on their present usage will result in energy cost savings due to a reduction in electrical energy consumption by the chillers and fan motors and the reduced natural gas consumption in the boiler.

THE STRATEGY

Replace the drive sheaves and belts on the fan drive of AHU-1 and Exhaust Fan EF-1-3. Retain the existing sheaves and belts for reuse should the areas served revert to their designed intended use.

RECAP OF SAVINGS

Annual Energy Savings		
Electricity	46050 KWH or 157 MBTU	= $ 958
	14.67 KW	= $ 1,425
Gas/Oil	(74.9 MBTU)	= $(270)
Total Annual Cost Savings		= $ 2,113
Implementation Cost		= $ 1,169
Simple Payback		= 0.6 years

The estimated useful life of this ECM is 10 years.

ECO #H
ABSTRACT
KVA PEAK DEMAND REDUCTION

Electricity consumed in the USAARL is actually billed by the Alabama Power Company (APC) to Fort Rucker as part of the entire post power service. Fort Rucker purchases electricity from the Alabama Power Company under the Rate Schedule MR-1. There are two charges for electricity. The monthly rates are $9.249/KVA of billing demand and 2.15 ¢/KWH. The billing demand is the greater of either the current month demand or 75% of the highest actual demand established in the previous eleven months. This is known as a "75% rachet clause."

Control of KVA demand peaks in commercial facilities with large lighting, cooling and personnel content offers potential for energy savings and certainly the capability for substantial cost savings. These cost savings are a result of the rate structure of many utilities. Rate structures that charge premium prices for the KW or KVA demand and low prices for the energy consumption in KWH provide a substantial opportunity to the consumer for energy cost savings. The ratchet clause on peak power causes savings in KW billing demand in warm weather months to be applied to the following cool weather months.

Cost savings can be achieved by management of the peak KVA or KW in the summer months when cooling is required. This management can be achieved in a number of ways. Some of these are control of existing peak loads, supply of auxiliary power by on site fossil fired systems, or load shifting to off-peak hours.

THE OPPORTUNITY

The USAARL has a 365 KW generator in Building 6901 and a 215 KW generator in Building 6902.

It is proposed in this ECO to enhance the operation of these generating units by controlling them to operate when Fort Rucker is experiencing its peak demand and operating them at their full capacity.

This will reduce Fort Rucker's billing demand in warm weather months by as much as (365 + 215 =) 580 KW and in winter months by 75% of this figure (due to the APC rachet) to achieve a savings of as much as $44,321 per year.

THE STRATEGY

Provide a synchronizing unit and associated switchgear to provide a parallel path to the USAARL 480 volt buss for the existing generator-sets to provide power during peak power periods. The capability to use the generators as emergency units for the USAARL as well as manual control will be retained.

RECAP OF SAVINGS			
Annual Energy Savings			
Electricity	339300 KWH OR 1158 MBTU	=	$ 7,057
	580 KW	=	$ 56,330
Gas/Oil	(4136) MBTU	=	$(19,066)
Total Annual Cost Savings		=	$ 44,321
Implementation Cost		=	$119,000
Simple Payback		=	**2.7 years**
Line 6 SIR			3.85

The estimated useful life of this ECO is 25 years.